the ether, whose density is function of the velocity of propagation of light and heat, as also of the wave-lengths.

Multiplying all these masses by the square of the velocity of each particle relatively to the centre of gravity of the solar system, we obtain the factor $\frac{1}{2}Mv^2 =$ the total kinetic energy of the solar system.

This constant kinetic energy (if the second hypothesis be admitted, in which $\frac{1}{2}mv^2$ is constant) is not distributed throughout the solar system in a regular and fixed manner. Sometimes a planet, as Jupiter, is at the extremity of the larger axis of his ellipse, and advances more slowly; sometimes, on the contrary, his velocity is accelerated and passes through a maximum to another position of his orbit.

At the same minute all the planets are revolving round the sun, some with their maximum velocity, others with their minimum velocity, others, again, with intermediate velocities. We may make addition of all these kinetic energies of the whole solar system, and differentiate the total equation with reference to time. The *variations* thus obtained *for each hour* will naturally eliminate all the *quantities of constant kinetic energy* represented by the rotation of the stars on their own axes; they will merely show the increase or the diminution of the whole of the variable kinetic energies of the system.

One may easily draw a curve of these variations calculated by the ephemerides of the principal planets. Jupiter will play a preponderating *rôle* in this calculation.

Considering still the second hypothesis, in which the attraction is merely the result of shocks, it is evident that the attraction manifested by each planet for the bodies which are on its surface will be the echo of the kinetic energy disposable on this planet. *This kinetic energy will be variable according to the day and hour of observation.*

In fact, the kinetic energy of the solar system *being fixed and constant*, if the planets, on a certain day, absorb into their own mass a maximum quantity of kinetic energy, the *cause of gravity on the earth* will be diminished by the whole of the excess which is accumulated in these bodies in motion, and the *acceleration g* will pass through a *minimum*. On the other hand, when, a few years later, the whole of the planets give a minimum total of kinetic energy for their masses in motion, the value of g, for the same reasons, must pass through a maximum.

It is easily understood that the value of the terrestrial attraction cannot remain constant if the disposable kinetic energy varies in function of the time and of the respective position of the other planets.

Now, we may calculate the total mass M of the system, the partial masses and their variable velocities; we obtain for these variations *considerable values*; then if we register carefully the values of g obtained directly during observations which must continue at the least several years, and if we trace a curve of the values of g so obtained, we should find the following coincidence:—

The curve of variations of the total kinetic energy of the planets must be inverse to the curve of values of g referred to the same time.

The differences between the maxima and the minima of the two curves, taken on the same ordinate, will give the measure of the velocity of propagation of the kinetic energy in the ether of the solar system.

These conclusions are rigorous in the case of the hypothesis,

$$\tfrac{1}{2}mv^2 = \text{constant},$$

being in accordance with nature.

In the case, on the other hand, of attraction being an essential property of matter, and of our having—

$$\tfrac{1}{2}mv^2 + \text{the potential} = \text{constant},$$

we should find for g a *constant*, since g is the sole manifestation of a constant potential, supposing the mass of the earth is constant during the course of the observations of g.

It will be necessary, then, to take account of perturbations of the moon for the measurements of g, as also of those of the sun, then to verify whether, these corrections having been made, g is constant.

I believe that this experimental method is the only means we possess of diagnosticating with certainty on the essential properties of matter, and of deciding between those two great theories which are both maintained by men of incontestable merit.

As to the measurement of g, there are several operative processes, and it will be indispensable, before commencing observations, to discuss analytically the advantages of each of them, and the modes of inscription of the values obtained.

The optical means of registration, the mechanical actions connected with the motion of pendulums, and the kind of pendulums, will be so many important subjects of discussion, in the case of taking these researches in hand, which I consider as very useful for the definitive settlement of physical theories.

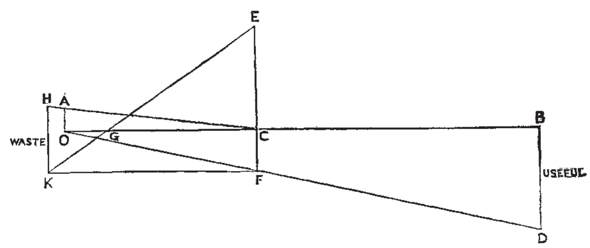
This is a rather long letter, you see, dear Teacher; but I thought to explain to you the object which I pursue, in its general traits, happy indeed if the experiments may be undertaken under your benevolent auspices.

Accept, dear Teacher, I pray you, the expression of my gratitude and entire devotion. RAOUL PICTET

A GEOMETRICAL CONSTRUCTION GIVING THE RELATION BETWEEN THE WASTE AND USEFUL WORK IN A SHUNT DYNAMO

THE ratio between the portion of electrical energy utilisable in the external circuit of a shunt dynamo and the portion wasted in heating the wire of the armature and field magnet is easily calculated as soon as one knows the resistances of the armature and magnet wires, and the resistance equivalent to the external circuit; and I do not know that there is any great advantage in putting it into a geometrical form. Still there are people who prefer a construction to a formula, and the following construction is easily made, especially with the use of squared paper.

In the figure annexed, let O A represent the resistance of the armature between the points where the branching occurs; O B



the resistance of the field magnet wire; and O C the resistance of the external circuit, or its equivalent.

Erect lines to represent the useful work (E.M.F. × current), on any convenient scale, at C and at B; viz. C E and B D.

Join O D, producing E C to meet it at F.

Lay off C G equal to E F; draw E G and a horizontal through F.

Then from their meeting point K draw a vertical, meeting C A in H.

The length H K so determined represents the waste portion of the total electrical energy, on the same scale as B D or E C represents the useful.

In this figure the effect of the armature resistance in tilting up the line C A and so increasing the waste is very manifest; the increase of waste by decreasing the resistance O B is somewhat less striking, but quite distinct; the effect of a change in O C is, as it should be, not so obvious. It may be noted that the most economical value for O C is very nearly indeed a geometric mean between O A and O B–O A; which is an easy rule to apply in practice.

Liverpool, July 19 OLIVER J. LODGE

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THE following is the list of candidates successful in the competition for the Whitworth scholarships, 1882, in connection with the Science and Art Department:—Charles Webster, apprentice; John H. Tomlinson, apprentice; James M. Beaman, fitter; Thomas Turner, engineer; D. Codrington Selman, engineer; Charles B. Outon, draughtsman; George H. Banister, draughtsman; Frederick Lane, fitter; William D. Laird, engine fitter; Joseph Parry, engine fitter; Albert F. Ravenshear, apprentice; Charles W. Carter, brass-finisher; Alfred Barrow, fitter; Henry C. King, fitter; Malcolm Douglas, apprentice; Thomas H. Gardner, engineer; Ernest E. Haine, engineer; George Halliday, engineer; George W. Buckwell, draughtsman; Louis H. Cochrane, engineer; William Duncanson, engine fitter; Henry Brown, engineer; William T. Hatch,

apprentice; Thomas Carlyle, draughtsman; Alfred J. Hill, draughtsman.

A TECHNICAL school is about to be established at Leicester, the main features of which will be to give instruction in the technology of spinning, and the technology of framework knitting. The governors of the Wyggeston Schools have given 1000*l.* towards this object, the Science and Art Department, South Kensington, has promised 500*l.*, 1000*l.* has been raised by subscription, and another 1000*l.* is all that is required to complete the scheme for the present. The movement has been undertaken by the Chamber of Commerce and the Rev. Canon Vaughan. Mr. Henry Mitchell, president of the Bradford Technical School, has received from the Worshipful Company of Clothworkers, London, an intimation to the effect that they have decided to give 300*l.* a year towards the maintenance of the school.

SCIENTIFIC SERIALS

Bulletin de l'Académie Royale des Sciences de Belgique, No. 5.—On the coralline origin of Devonian limestones of Belgium; reply to M. Dupont, by G. Dewalque.—Photography on the railway and in balloons, by R. Candèze.—On surfaces of involution, by E. Weyr.—On the integration of a class of equations with partial derivatives of the second order, by F. G. Teixeira.—Note on a new method for measuring the resistance of batteries, by P. Samuel.

Journal de Physique, June.—Electrical phenomena of hemihedral crystals with inclined faces, by Jacques and Pierre Curie.—Historical researches on the standards of weights and measures of the observatory, and the apparatuses that have served in their construction, by C. Wolf.—Units adopted for absolute measures by the International Congress of Electricians, by H. Pellat.—Thermodynamic analogy of thermoelectric phenomena and the phenomenon of Peltier, by E. Bouty.—Assimilation of the experiments of Hall and Faraday to the effects of the gyroscope, by B. Elie.—Magnetic gyroscope, by A. Crova.

Atti della R. Accademia dei Lincei; Transunti, vol. vi., fasc. 12.—On the pigments of bile, by S. Moreggia.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, July 17.—M. Blanchard in the chair.—The following papers were read:—Report on a memoir by M. Ph. Gilbert on various problems of relative motion, by a Committee. This memoir is a study of the motion of gyroscopic apparatus, viz. (1) Foucault's gyroscope; (2) the torse-pendulum, which the author modifies, getting a more sensitive form, the *barogyroscope;* this may be used instead of Foucault's instrument to prove the earth's rotation; (3) the top. The newest and most original part of the work is that relating to (2).—On a point of the theory of perturbations, by M. Radau.—Astronomical observations without measurement of angles, by M. Rouget. He designates them *circumzenithal.*—On the shock of a plane elastic plate, supposed indefinite in length and in width, by a solid which strikes it perpendicularly at one of its points, and which remains united to it, by M. Boussinesq.—On the variations of gravity, by M. Mascart. The idea of measuring variations of gravity at different points of the globe by the height of the mercury column which balances the pressure of a given mass of gas at constant temperature, M. Mascart has sought to realise, and he finds the method capable of great precision. He uses a kind of siphon-barometer with the short branch closed and holding CO_2, introduced at a pressure sufficient to balance a mercury column of 1 m., when the tube is vertical. The instrument is placed in a metallic cylinder filled with water, which is agitated by an air-current, and contains a thermometer measuring $\frac{1}{100}$ deg. The divided scale is fixed on the tube; one sees it by reflection on a gilt surface, which sends the virtual image into the axis of the tube, and the mercury is seen through the gold layer. Thus one can see, with a single microscope, the mercury-level and the corresponding division of the scale. M. Boussingault recalled having used a similar apparatus during his stay at Ecuador, near the mines of Marmato (1,600 m. alt.) Not finding any variation in the mercury column, he inferred there was no perceptible change in the intensity of gravity during the experiment.—On lightning conductors, by M. Melsens. In support of his system of multiple conductors forming a sort of cage, he cites the experiment in which animals within a metallic cage are unharmed by discharge of a powerful battery of Leyden jars through the cage.—On the hydrate of sulphuretted hydrogen, by M. de Forcrand. A claim of priority.—Researches on the use of crusher-manometers for measurement of pressures developed by explosive substances, by MM. Sarrau and Vieille. They attached to the piston of the crusher a thin piece of leaf-steel to mark a rotating blackened cylinder; and the curve, at explosion, was compared with a sinuous trace made by a tuning-fork at the same time. Results are promised soon.—On the limiting degrees of nitrification of cellulose, by M. Vieille. Cotton wadding was put in 100 to 150 times its weight of nitric acid of various degrees of concentration and at 11°. The last nitrated product obtainable thus is mononitrated cotton (liberating 108 c.c. of bioxide of nitrogen); it is got from nitric acid with 3 eq. of water (density 1·450). By use of sulphonitric mixtures, the author reached, as upper limit, a liberation of 214 c.c. of bioxide of nitrogen, nearly corresponding to the formula $C_{14}H_{29}(NO_4)_{11}O_{10}$.—Influence of compressibility of elements on compressibility of the compounds into which they enter, by M. Troost. The variation of the coefficient of compressibility of vapour of iodine appears again in the vapour of iodide of mercury.—On the derivatives of cupreous sulphites, by M. Etard.—On the gastric juice, by M. Chapoteaut. The aqueous solution of gastric juice (dried and washed previously with ether), treated with alcohol or sulphuric acid, gives a white precipitate, which appears to be the active principle of the juice; its composition is near that of albumen.—On the products of distillation of colophany, by M. Renard.—On a new class of cyanised compounds with acid reaction; cyanomalonic ether, by M. Haller.—On two new antiseptics, glyceroborate of calcium, and glyceroborate of sodium, by M. Le Bon. The latter (and better) has the advantage over carbolic acid of being soluble in water in all proportions, and quite harmless. For disinfection, meat preservation, &c., its fitness is established.—On the industrial conditions of an application of cold to destruction of germs of parasites in meat destined for food, by M. Carrè. With the author's apparatus as applied since 1876 in vessels for importation of meat from La Plata, &c., the cost price is slightly under 0·01 franc per kilogramme. The temperature of $-40°$ or $-50°$ applied for an hour or so is fatal to germs; this is reached in the domestic apparatus (with ammonia).—On the visibility of luminous points, by M. Charpentier. With equal brightness and distance this visibility is directly proportional to their surface, or the square of their diameter; with equal brightness and dimensions, inversely as the square of their distance from the eye; with equal dimensions and the same distance, directly as the illuminations.

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